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ABSTRACT

This paper describes the development of two World Wide Web sites, "Our Place in the World" (OPITW) and "Chicana and Chicano Space" (CCS), specifically designed as resources for art educators, and describes a framework for three blended levels or layers of navigation that support knowledge construction within the domain. The first section of the paper discusses the elements of educational hypermedia environments, including: (1) the relationship between the site and the user; (2) learner/user elements, i.e., computer skills, content knowledge, self-efficacy, learner control, and task type; (3) macro and micro conditions of hypermedia design; and (4) site elements, i.e., content, presentation, navigation, and links/nodes. Ill-structured domains and cognitive flexibility are discussed in the second section, including the notions of "concept- and case-complexity" and "across-case irregularity." This is followed by a section that addresses thematic and inquiry-based learning. The final section describes the three layers of navigation used in the OPITW and CCS web sites--near-linear navigation, guided navigation, and self-directed exploration. Two tables present: elements of hypermedia learning environments and macro and micro levels of relevance, usefulness, and accessibility of hypermedia learning environments. Recommendations for application of this framework for other hypermedia and hypertext curriculum resource environments are included. (Contains 27 references.) (DLS)

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Layers of Navigation: Hypermedia Design for an Ill-Structured Domain

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Abstract

In this article, two web sites developed specifically as curriculum resources for art educators are presented. While the sites were not designed to address specific principles of cognitive flexibility theory, we make a case that a thematic approach to inquiry-based art education delivered in a hypermedia environment designed with three layers of navigation is appropriate for an ill-structured domain such as art. An early response from teachers participating in an on-line seminar suggests that the complexities of inquiry in art are well presented in a hypermedia environment, that reductive bias is minimized, and that this environment is useful, relevant, and accessible. This article focuses on the development of the sites and describes a framework for three blended levels or "layers" of navigation that support knowledge construction within the domain: near-linear, guided, and self-directed exploration. Recommendations for application of this framework for other hypermedia and hypertext curriculum resource environments conclude the article.

Too often, web sites are developed for instructional uses without the aid of sound instructional design principles. These sites appear on lists of Internet resources for teachers and can confuse novice computer users and novice teachers. Content is presented as static, verbal information pages linked to other information pages that may or may not include obvious or intuitive navigational cues. That is, information is delivered with the new technology but the format of the presentation may confuse or "lose" the novice and intermediate user.

Designing instruction for instructional hypermedia and hypertext requires thoughtful attention to certain aspects of learning, particularly when designing for ill-structured domains. Over-simplification of the complexities of an ill-structured domain encourages novices to reduce the "solutions" of domain-specific problems to simplified or cook-book answers, which is known as reductive bias (Spiro, Feltovich, & Coulson, 1992).

In ill-structured domains such as art, an over simplification of the domain (e.g., the reduction of learning in art to production skills and selected historical data), masks the complexities of cultural context and the interconnectedness of aesthetics, criticism, production, and history in the art world. Similarly, teacher education programs in art and in-service opportunities for novice art teachers or classroom generalists (elementary educators); have in the past reduced the art experience to a production of "happy hands and holiday" non-art projects.

In this article, two web sites (Erickson, 1996; Erickson & Cárdenas, 1997) developed specifically as curriculum resources for art educators are presented. While the sites were not originally designed to address specific principles of cognitive flexibility theory (Jacobson, 1995; (Spiro, et al., 1992), we make a case that a thematic approach to inquiry-based art education delivered in a hypermedia environment designed with three layers of navigation is appropriate for an ill-structured domain such as art. An early response from teachers participating in an on-line seminar suggests that the complexities of inquiry in art are well presented in a hypermedia environment, that reductive bias is minimized, and that this environment is useful, relevant, and accessible (seminar discussions may be found at: http://www.artsednet.getty.edu/ArtsEdNet/hm/May97/0006.html). This article focuses on the development of the sites and describes a framework for three blended levels or "layers" of navigation that support knowledge construction within the domain, both in terms of new content knowledge and as an approach for novice teachers to use to teach art. Recommendations for application of this framework for other hypermedia and hypertext curriculum resource environments conclude the article.

Relevance, Usefulness, and Accessibility of Hypermedia Environments

Much has been written about the educational potential of hypermedia environments such as the world wide web (WWW), however, not all web sites or CD's are educational in their intent. For purposes of this article, we will

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define educational hypermedia as those environments designed and developed specifically for use as educational resources or as a basis for instruction.

Elements of Educational Hypermedia Environments

The relationship between the site and the user. Successful educational and instructional hypermedia environments are more than the information presented. That is, in successful educational web sites, there appears to be a synergistic relationship between the information at the site, the authors of the site, and the users of the site. Several articles have identified elements of this synergy (Barrett, 1992; Carlson, 1991; Corry, Frick, & Hansen, 1997; Hill & Hannafin, 1997; Jonassen, 1991; Jonassen & Wang, 1993; Locatis, Charuhas, & Banvard, 1990; Schroeder, 1994; Spiro, et al., 1992; Spiro, Feltovich, Jacobson, & Coulson, 1991), but few have presented them as a unified whole. Table 1 is a first attempt at illustrating the user and site characteristics designers consider when developing successful educational web sites.

Table 1. Elements of Hypermedia Learning Environments

Learner/User Elements	Site Elements
Computer Skills	Content
Content Knowledge	Presentation
Self-efficacy	Navigation
Learner Control	Links and Nodes
Task type	

Hill and Hannafin (1997) recently identified several learner/user elements illustrated in Table 1: Computer skills, or the ability to use the computer and by implication a WWW browser, was defined as system knowledge (p. 39). They defined content knowledge specifically as prior subject knowledge (p. 39). Such prior knowledge is critical to the acquisition of new subject or content knowledge. Self-efficacy "...refers to a personal judgment of one's capability to execute actions required to perform" (p. 39). In other words, the confidence of the learner/user in his or her ability to use the computer and link new information to previously learned information has a great impact on how one uses the site and on how much the learner/user will persevere in acquiring new information.

Learner control is another element that has been discussed at length in designing effective instruction (Hooper, Temiyakarn, & Williams, 1993; Malone & Lepper, 1987; Morrison, Ross, & Baldwin, 1991; Ross & Morrison, 1992) and is of particular relevance in hypermedia environments. However, because of the complexity of ill-structured domains, total learner control may not be an effective design feature. Cognitive overload may occur as learners branch further and further from the site in search of content knowledge (Spiro, et al., 1992).

Related to learner control is task type. The type of task a learner/user has in which a learner engages when entering an educational hypermedia environment appears to determine his or her path through the site (Barab, Bowdish, & Lawless, 1997). From an art education perspective, task type in an ill-structured domain such as art is closely tied to thematic and inquiry-based learning (discussed below) in that the theme and line of inquiry shape the task.

Previous researchers (Conklin, 1987; Jacobson & Spiro, 1995; McLellan, 1993; Recker, 1994; Schroeder, 1994) have identified site elements using a variety of terms. We will consider the list in Table 1 as a basis for our discussion of site versus user elements. The site elements Content, Presentation, Navigation, and Links and Nodes; refer to the information itself, how it is presented to the learner/user, how the learner moves within the site, and how information is linked to other information respectively.

While either set of elements might be considered separately, hypermedia design appears to be most successful when it is purposefully designed to cross learner/user elements with site elements. Though most educational hypermedia environments must address all of the elements in some degree, our focus in designing the three layers of navigation is primarily on task type and navigation.

Macro and micro conditions of hypermedia design. In addition to learner/user elements and site elements, three conditions for educational hypermedia appear to play a role in the success or failure of the hypermedia environment to support and facilitate learning: relevance, usefulness, and accessibility. Each condition has two levels that incorporate the larger educational context of the user (macro level) and the user as an individual (micro level). Table 2 presents these conditions related specifically to art education.

Table 2. Macro and Micro Levels of Relevance, Usefulness, and Accessibility of Hypermedia Learning Environments

Condition	Macro Level	Micro Level
Relevance	Relevant to social, institutional (school), community, and curricular expectations.	Personal relevance to teacher and learner: the environment affords connections to prior experience and/or aids in delivery of instruction in local learning context and discipline.
Usefulness	Appropriate presentation of instructional (and artistic) media for structured and ill-structured domains.	Use of the hypermedia environment reinforces teaching and learning in art content areas.
Accessibility	Socio-cultural implications of accessing hypermedia: race, gender, socio-economic status, availability of technology, and the ability and skills needed to use technologies.	User interface or presentation: organization of content, verbal and non-verbal presentation, graphic, thematic, or concept map navigation within the instructional application facilitates learning and minimizes disorientation.

Relevance. Relevance refers to the relationship the product and idea technologies have to the user. Relevance, in the sense of the ARCS model of motivation theory (Keller, 1979), is the condition that mediated instruction should be connected to the teacher and learner's personal goals and values. Relevant web sites for instructional needs are often a matter of individual perception, but may well be a matter of availability of appropriate (relevant) sources. For example, graphic software is highly relevant to art production classes but may be less relevant when discussing aesthetics.

Usefulness. Usefulness, as defined for this article, is the condition that relates to the application of different hypermedia environments to learning. Usefulness also describes using the technologies to the appropriate level of their potential, and in the appropriate macro and micro context. The technology may be very relevant to the instruction (e.g., a downloaded educational game in art history) but might be found to be useless in terms of learning: the game is fun but contributes little to the learning context. Usefulness in our definition should not be confused with usability (Corry, et al., 1997).

Accessibility. Accessibility on a macro level, refers to the social and cultural constraints, capabilities, and implications of access to the hypermedia environment and to the technology (Borrell, 1992; Piller, 1992), particularly in the areas of race, socio-economic status, and gender. On a micro or local level, accessibility is concerned with socio-cultural issues but focuses attention on individual access and use of the technology and the hypermedia environment.

Ill-structured Domains and Cognitive Flexibility

Novices in ill-structured domains have several difficult obstacles to overcome before they are welcomed into the culture of the expert. Medical students encounter patients whose symptoms do not conform to textbook examples, budding physicists struggle to leap from ordered word problems to speculating on the nature of motion, and student teachers find that teaching methods are seldom performed "by the book" in real classrooms. Novice art educators have the added task of dealing with a content area that is so ill-structured that it is often assumed to lack substance or discipline.

Ill-structured domains are those which may be characterized as having two distinct and interconnected properties: "concept- and case-*complexity*," and "across-case *irregularity*" (Spiro, et al., 1992, p. 25). Briefly stated, concept and case complexity requires that learners (students, artists, teachers) hold several often conflicting concepts in mind when confronting a case within the domain. In art, cases may be particular problems in aesthetics, history, criticism, or creating a work of art. For example, seeking to understand an artwork from another culture, such as a 19th century Sioux decorated container (art history problem) may require one to hold in mind such diverse concepts

as climatic conditions, the relationship of geometric shapes, and pre-industrial art making techniques (Erickson, 1996). In advanced art courses, case complexities and irregularities such as these increase across art media and art concepts.

The irregularity of similar cases, that is, the necessity of applying different concepts and actions to a case that might resemble a previously encountered case, is often encountered in art and may indeed play a major part in how art movements are started. For example, an aristocratic portrait from Colonial New Spain; a representation of the Mexican Revolutionary hero, Zapata; a mural by Diego Rivera; and a feminist self portrait as the Virgin of Guadalupe (Erickson & Cárdenas, 1997) are examples of an application of very different concepts and actions to the "common" problem case of painting a portrait.

The two web sites described in this article are designed to guide and support the art educator in developing curriculum for art education while providing some sense of case complexity and irregularity. The above examples of case complexity (seeking to understand artwork from another culture) and case irregularity (portrait painting) are illustrations drawn from the two web sites. In turn, the lessons and supplements presented provide the K-12 art students with some insight and a window on learning in art. Well designed instructional hypermedia and hypertext environments should offer learners rich and challenging instructional contexts that foster learning in complex or ill-structured domains. Novice learners in such domains as art or medicine, are largely struggling to understand the complexities of the domain itself. Add to this the necessity of learning with and from an educational technology that affords a non-linear mode of accessing information, and the result can be disorientation and cognitive overload (Conklin, 1987; Jacobson & Spiro, 1995; Spiro, et al., 1992).

By overlaying the information with a thematic and inquiry-based organizational scaffold and through the application of sound instructional design elements, much of the confusion and disorientation can be minimized without sacrificing the presentation of the complexities of the domain. We identified navigation as the most critical support for the thematic and inquiry-based approach to this domain.

Thematic and Inquiry-based Learning

In "Our Place in the World" (1996) and "Chicana and Chicano Space" (1997) web sites, content is organized within a thematic, inquiry-based approach that uses a series of questions to help students' learning. Students in the K-12 art education classroom learn to formulate additional questions and search for answers through their own art experiences and by researching appropriate sources. Learning in a thematic, inquiry-based classroom is student-centered rather than teacher led; and encourages student elaborations on the themes and questions to promote deeper processing (Hannafin & Carney, 1991; Wilson & Cole, 1992).

Our Place in the World (1996) focuses on four key inquiry questions:

1. How is the reproduction different from the original artwork?
2. How was the artwork made?
3. What visual elements did the maker choose?
4. What was the natural world like where the artwork was made?

Students explore art making questions related to four inquiry questions and apply the inquiry questions when they make their own art and when they study two artworks from the past (an Ice Age cave painting of a bison and a 19th century Sioux parfleche case). The theme, Our Place in the World, provides an overall direction for thinking about the two art works as they relate to each student's new experience in art.

Chicana and Chicano Space (1997) presents another inquiry-based, thematic unit called "Protest and Persuasion." This unit focuses on the following key inquiry questions:

1. What can I learn about the tools, materials, and processes the artmaker chose?
2. What can I learn about how the patron, user, or viewer understood the artwork?
3. What visual elements do I see?

Students apply the three inquiry questions to art making as they plan and produce their own print or mural and as they investigate the twenty Chicana/Chicano, Mexican, and Mesoamerican artworks posted on the site. The theme of Protest and Persuasion provides a focus for their thinking about these artworks as well as for their own art making experience.

Thematic instruction from a teacher's perspective is not new. Themes, particularly in elementary classrooms, provide a useful means to support deeper understanding and a context for learning. In ill-structured domains, thematic instruction guides students through the learning context by following a theme through a variety of situations thus promoting an experiential learning context with guidance to facilitate learning. Key inquiry questions help students understand the domain and can introduce new levels of complexity without overwhelming

the student. In this way, the task of moving through the site is organized around themes and inquiry rather than strictly by linear step-by-step links, though novice teachers may navigate the site in a variety of ways.

Layers of Navigation

"Our Place in the World" (OPITW) and "Chicana and Chicano Space" (CCS) curriculum resource web sites were designed for teachers to use rather than for K-12 students. Within the sites, sets of lesson plans and suggested paths are presented that help the teacher develop a thematic, inquiry-based approach to art education. Beginning and experienced art teachers often have a difficult time presenting the world of art and its complexities to their students. While the themes and questions suggest certain paths through the content, navigational considerations for beginning and experienced teachers were needed.

As the prototype for OPITW was formed, we found that the natural flow of the content design could become too linear if translated directly from the lesson plans to a hypertext or hypermedia environment, even though we had the option of hot linking terms and ideas. When these materials are presented in a classroom to beginning teachers, a large amount of dialog and experimentation with themes and questions becomes the focal point of the class. Our vision was to create a site that could provide this kind of interaction with the content and yet at the same time guide the novice user and beginning teacher through the materials.

To accomplish this goal, three layers of navigation; near-linear, guided, and self-directed exploration; were designed to address the needs of novice teachers without sacrificing the complexities of the content. These layers roughly parallel the three levels of use described in the Jasper Series from the Cognition and Technology Group at Vanderbilt (CTGV) (1992).

There, through a series of scenarios, K-12 learners are presented with learning tasks that are "anchored" to "real world" problems; an approach CTGV described as anchored instruction. The Jasper Series, as envisioned by the CTGV, allowed three levels of use; each level progressively less dependent on direct instruction. However, the Jasper Series materials retain many of the characteristics of instruction designed with traditional ID models: the materials tend to be design dependent, follow a somewhat prescriptive model, and are intended for a large audience, even though they take a more constructivist approach.

The levels of use for the Jasper Series attempts to address each continuum within each dimension. The Basics First level provides a means of teaching the components of solving Jasper problems, such as decimals, measurements, time, etc. before viewing the problem scenarios. Structured Problem Solving, the second level in the Jasper Series, provides a means of introducing complex problems with simple problems to help students avoid error and to break down complex problems into simple components. The third level, Guided Generation, provides a flexible context in which the problem is approached through cooperative groups, some guidance by the teacher as a resource, and the development of inquiry skills based on Vygotsky's (Vygotsky, 1978) concept of scaffolding.

The three layers of navigation in OPITW, while based on the model of CTGV's levels of use, are specifically designed for the teacher rather than for their students, and allow greater control than websites with only one or two layers of navigational strategies. Novice teachers and those who are more experienced, may move through the sites using three distinct navigation paths.

Near-linear Navigation

Near-linear Navigation may be defined as the path through the web site apparent from the homepage. That is, the OPITW and CCS web sites imply a path from Lesson One to Lesson Two and so on through each site, rather like the Basics First approach. Supplements and Extensions in OPITW might typically be accessed after all of the core lessons have been completed, and is very similar to a more traditional instructional approach. We see this strategy layer as being "near-linear" in the sense that users typically follow the path from one step to the next in sequence, but there is always an option for branching to other links, sections of the site, or different sites. OPITW and CCS are not closed or stand alone sites.

Guided Navigation

The Guided Navigation strategy layer allows the user to utilize a set of outlines, questions, or thematic paths provided on-line to structure navigation through the site. To further support Guided Navigation, a set of simple icons was created to graphically represent each of the themes and sets if inquiry questions. Thus teachers may explore themes in art education specifically or across content areas as an integration plan by individual schools. Materials included in OPITW and CCS may be accessed selectively for specific applications guided by the needs and parameters of the integration plan.

OPITW and CCS include a built in guided navigation strategy featuring the use of graphic icons. Teachers may click on an icon symbolizing the key inquiry questions as an alternative, less linear strategy for accessing curriculum materials. The guided questions and use of icons were a useful, relevant, and accessible means of helping novice teachers move through the sites' content and to expand upon thematic concepts.

In addition, a second guided navigation strategy is available to assist teachers in considering how themes and inquiry can improve their own teaching. An on-line seminar provided participating teachers with reflective questions, short tasks, and guided instruction during the first few months of the OPITW's availability on the Internet. A listserv moderated by the second author was put in place to provide an ongoing dialog with an expert while teachers used the site in their own classrooms. In this way, OPITW actually includes two types of guided navigation: those designed into the site as icons, themes, and inquiry questions; and those that were specifically asked during the on-line seminar sessions.

It is beyond the scope of this paper to discuss the results of the this Guided Navigation layer except to mention that teachers' response to the listserv and tasks were positive (see http://www.artsednet. getty.edu/ ArtsEdNet/hm/May97/0006.html). In many cases, this layer functions as another "theme" when using the site in the sense that teachers are guided by the tasks or needs of their curriculum plans. Further discussion of this layer will be available in a later article.

Self-directed Exploration

"Our Place in the World" and "Chicana and Chicano Space" may be accessed by experienced teachers who require the site to serve as a curriculum resource rather than a tool for improving their teaching. Ideas, key artworks, detailed information, inquiry questions, and icons, as well as the themes, may inspire more in-depth exploration throughout the WWW. In fact, "Protest and Persuasion" on CCS concludes with a lesson in which students are asked to use the theme to guide their own cruising of the WWW. OPITW and CCS offer a framework for lesson planning and curriculum development, yet at the same time foster further exploration of the domain.

Recommendations

Based on our experiences and on sound instructional design practices, we suggest that designers of web sites and other hypertext or hypermedia environments intended as educational or instructional resources for ill-structured domains consider the following set of considerations as a framework for good design:

1. Consider the elements of hypermedia environments and purposefully design for "cross over" between learner/user and site elements. By striving to merge site and user characteristics as illustrated in Table 1, designs for educational hypermedia environments become more useful, relevant, and accessible for a variety of novice to expert users. Sites that focus only on one set of elements (learner/user or site specific elements) may be appropriate for presenting verbal information, but are not useful for learning in ill-structured domains such as art.

2. Consider the segments of the domain to be presented. Use a thematic, inquiry-based approach to engage students in the content and to control cognitive overload. The sites discussed in this article make no attempt to cover the entire world of art. Rather, they guide learner/users through a series of strategies for moving through the domain by asking questions and by attending to suggested themes. Thus the domain is well represented, yet cognitive overload is reduced.

3. Reduce reductive bias by presenting a variety of cases with open-ended solutions. Increase complexity of the cases by presenting alternative extensions to the cases. Thematic inquiry-based learning provides a means of presenting cases with increasing complexity. By encouraging elaborations and curriculum extensions, case complexity and irregularity can be addressed as typical of an ill-structured domain.

4. Use a layers of navigation approach to support a variety of strategies for moving through the site and to facilitate learning in an ill-structured domain. If the designer pays attention to the interaction of site and user elements rather than to individual elements, the design has a greater chance of presenting the complexities of the domain while reducing disorientation and reductive bias.

Further experimentation in designing layers of navigation strategies for ill-structured domains is needed. The flexibility of instructional hypermedia and hypertext designs provide more opportunities to address higher order thinking in ill-structured domains. By attending to the elements of instructional hypermedia environments (learner/user and site specific) and by meeting the conditions of relevance, usefulness and accessibility; designers can meet the needs of learning in ill-structured domains. Developing and refining navigation strategies for

instructional hypermedia such as the three layers of navigation described above, will aid novices and experts in understanding the complexities of ill-structured domains while avoiding reductive bias.

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